Antarctic penguins and climate change.

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FONDATION TOTAL

IPHC Institut Pluridisciplinaire Hubert CURIEN STRASBOURG

cnrs dépasser les frontières

UNIVERSITÉ DE STRASBOURG

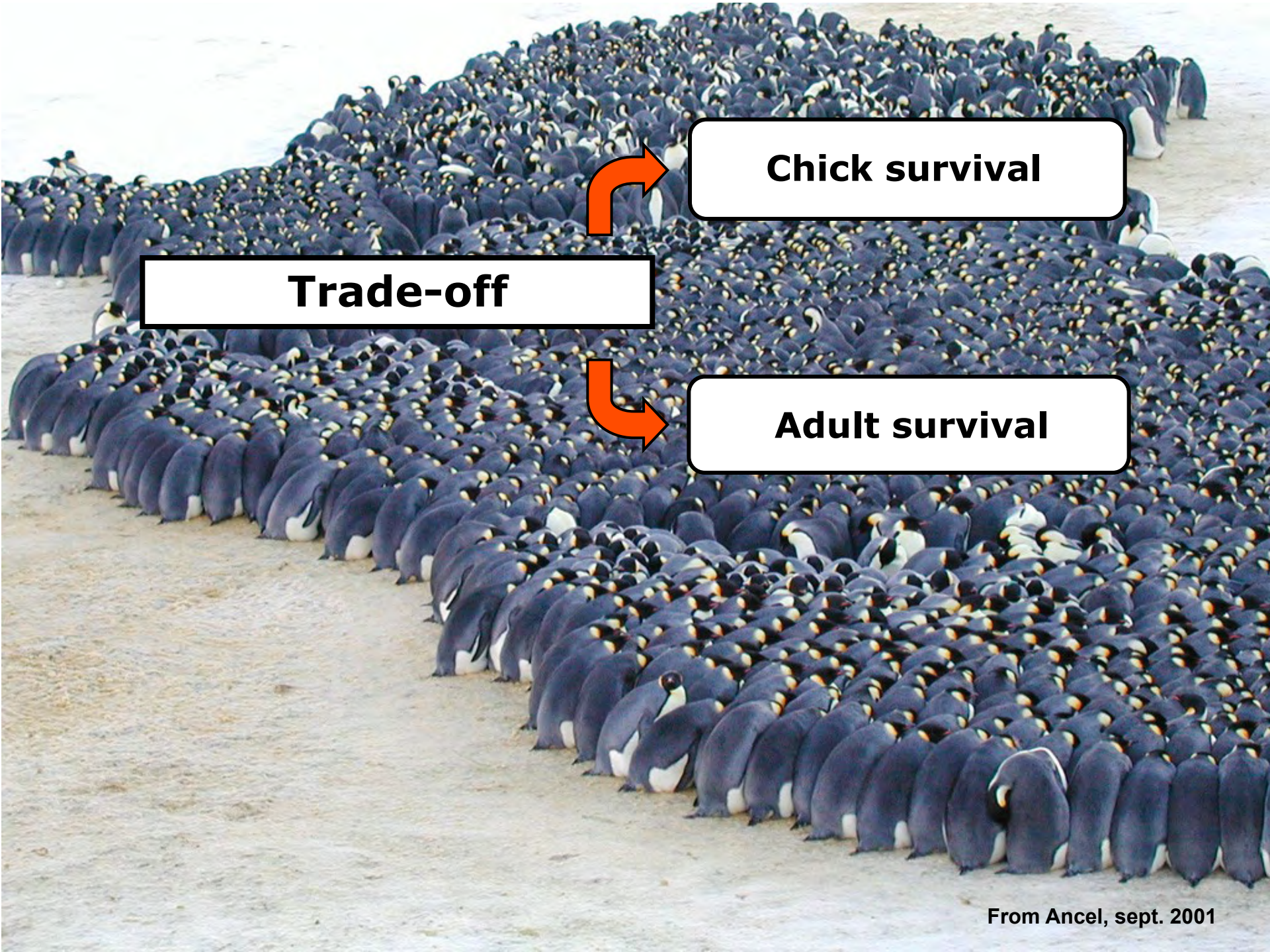
IPEV INSTITUT POLAIRE FRANÇAIS Paul Emile Victor

European Geosciences Union. GIFT workshop
Austria Center Vienna, 6 April 2011


DRIVE SLOWLY
CROSSING

One centimeter represents 750 kilometers.
One inch represents approximately 1200 miles.

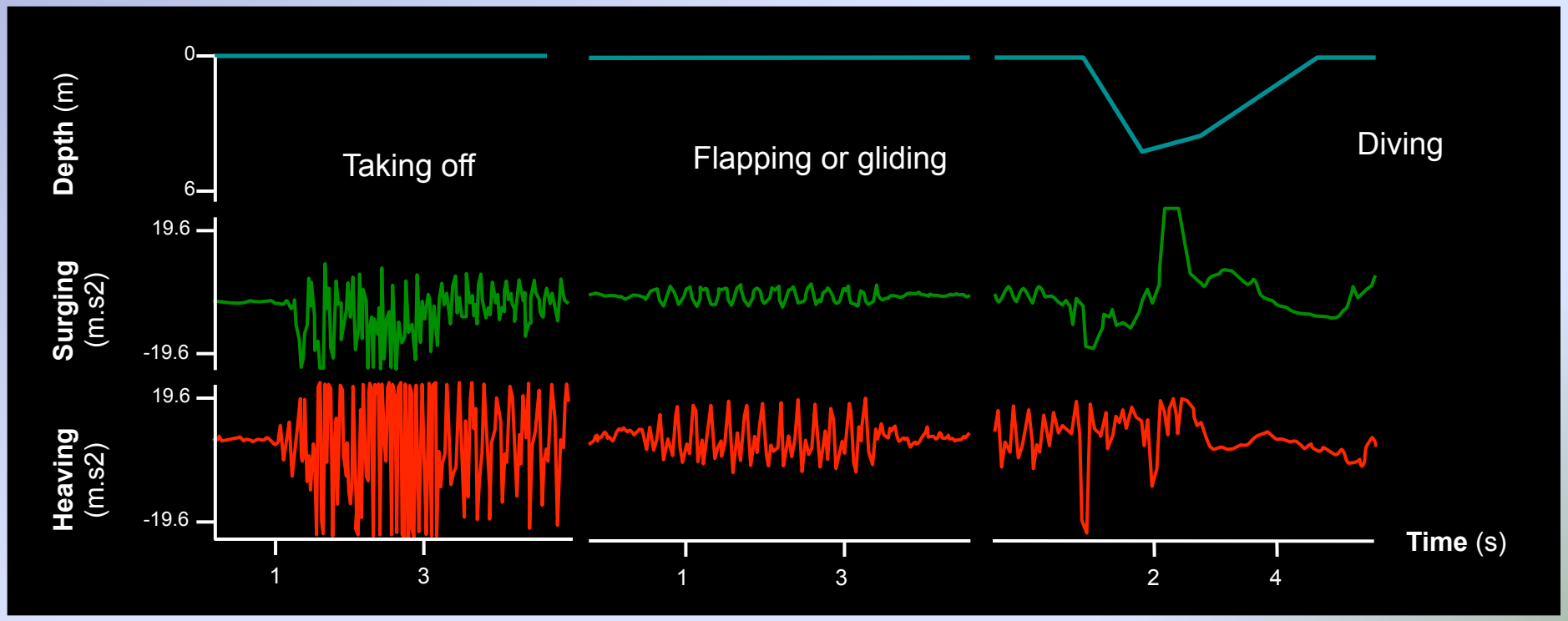
Scale 1:75,000,000

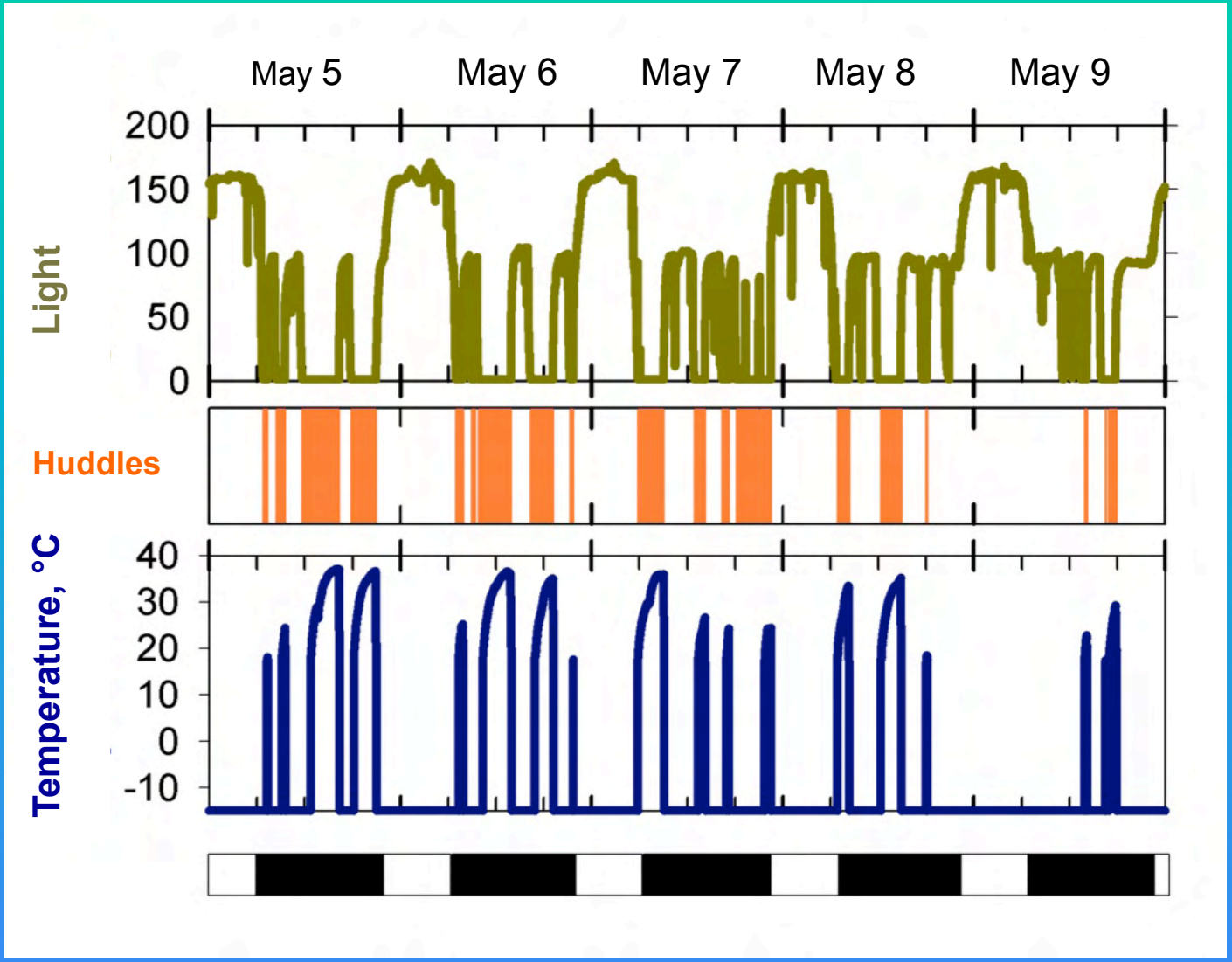


From Ancel, sept. 2001

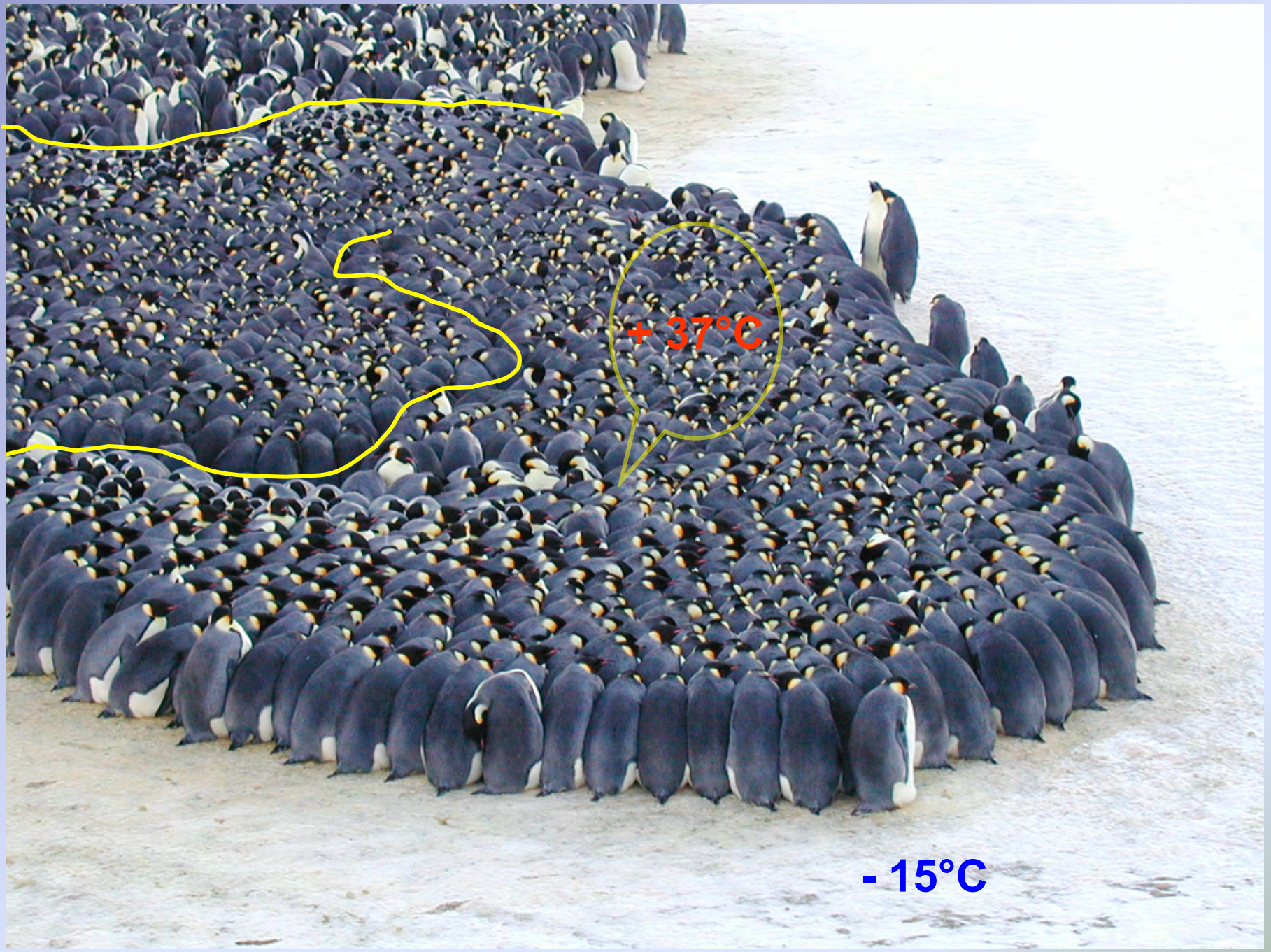
Bio-logging

Example: accelerometry and pressure.



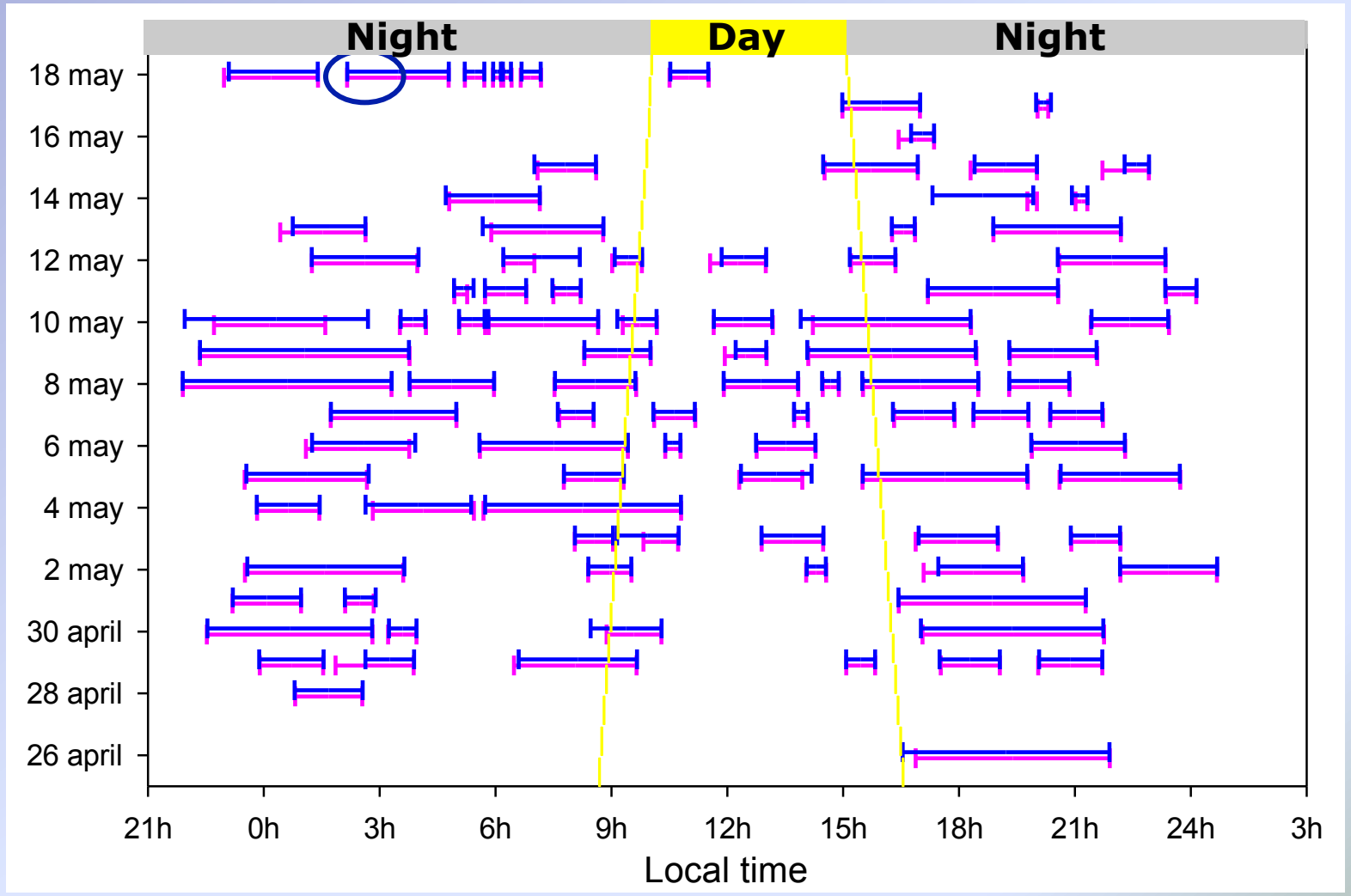


From Gilbert et al., *Physiology and Behaviour* 88: 479-488, 2006.

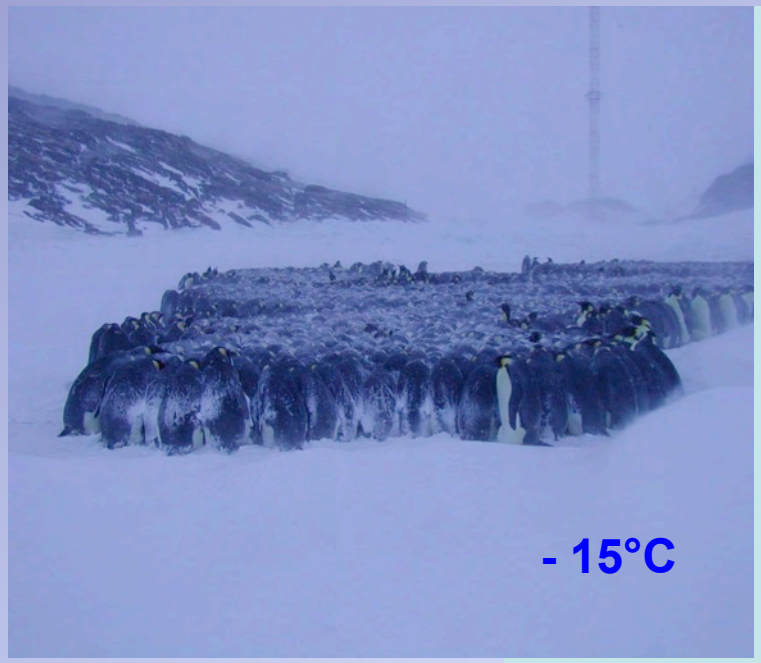

+ 37°C
- 15°C

Huddle duration: 1h30

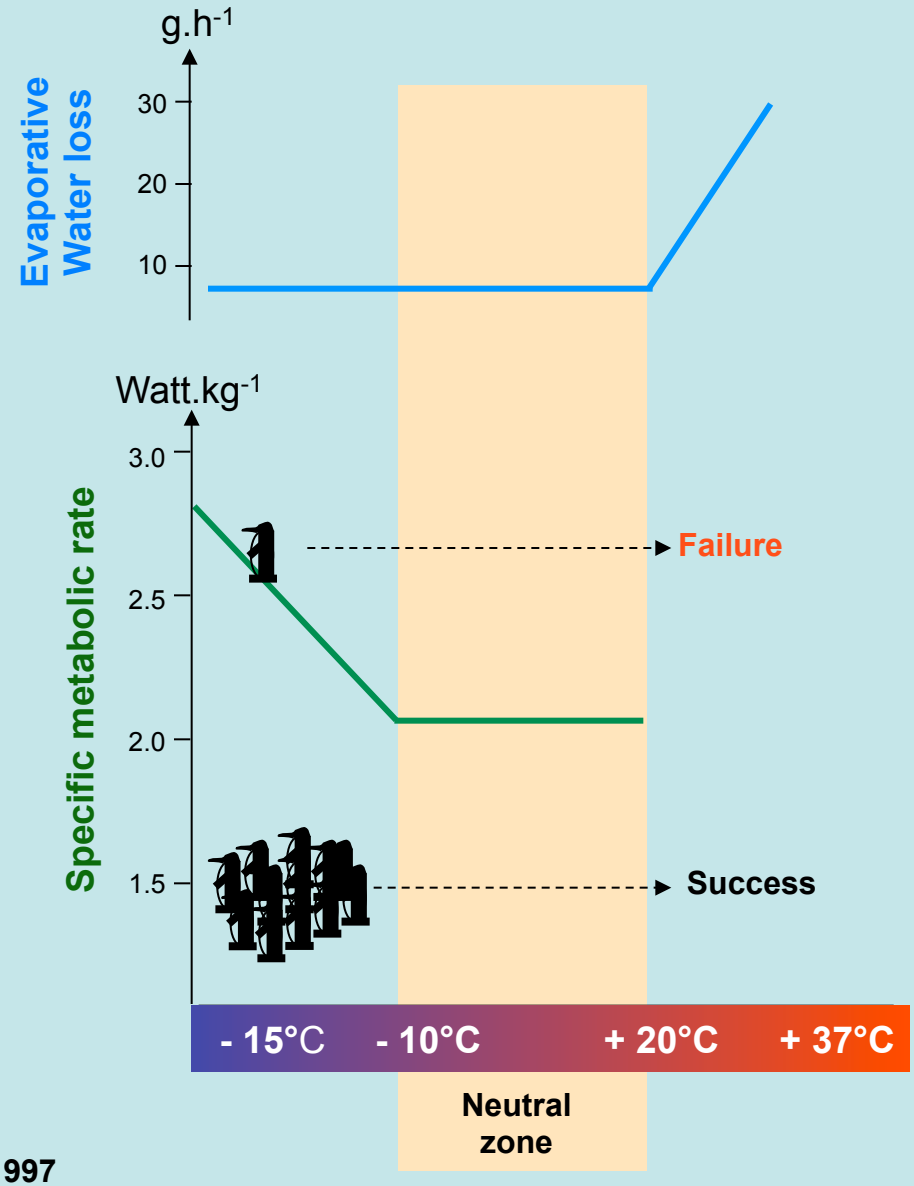
Gilbert et al. (2006) *Physiology and Behavior*



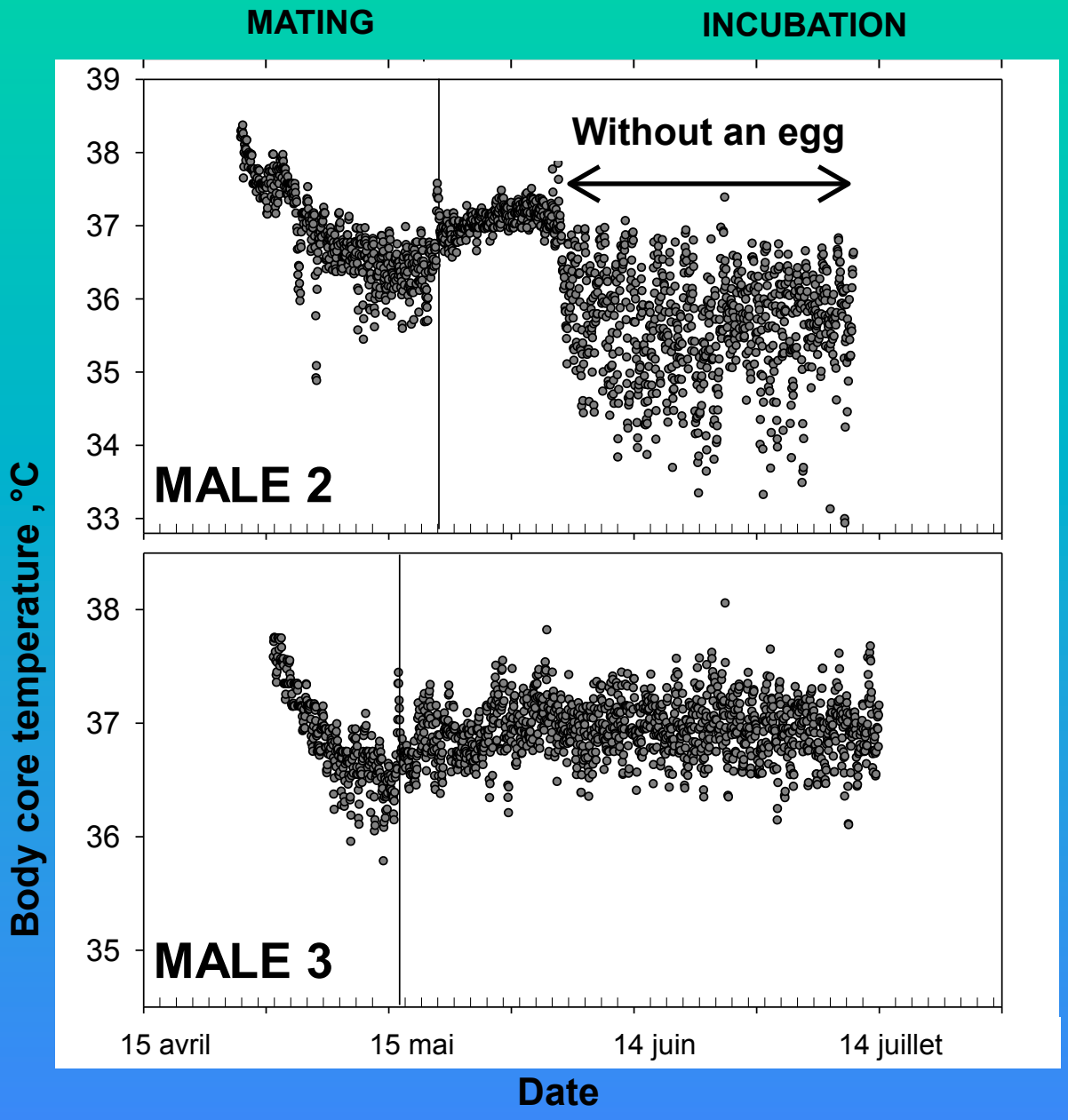
Ancel et al. (2009) *Proc. Royal Society* B



Huddling emperor penguins

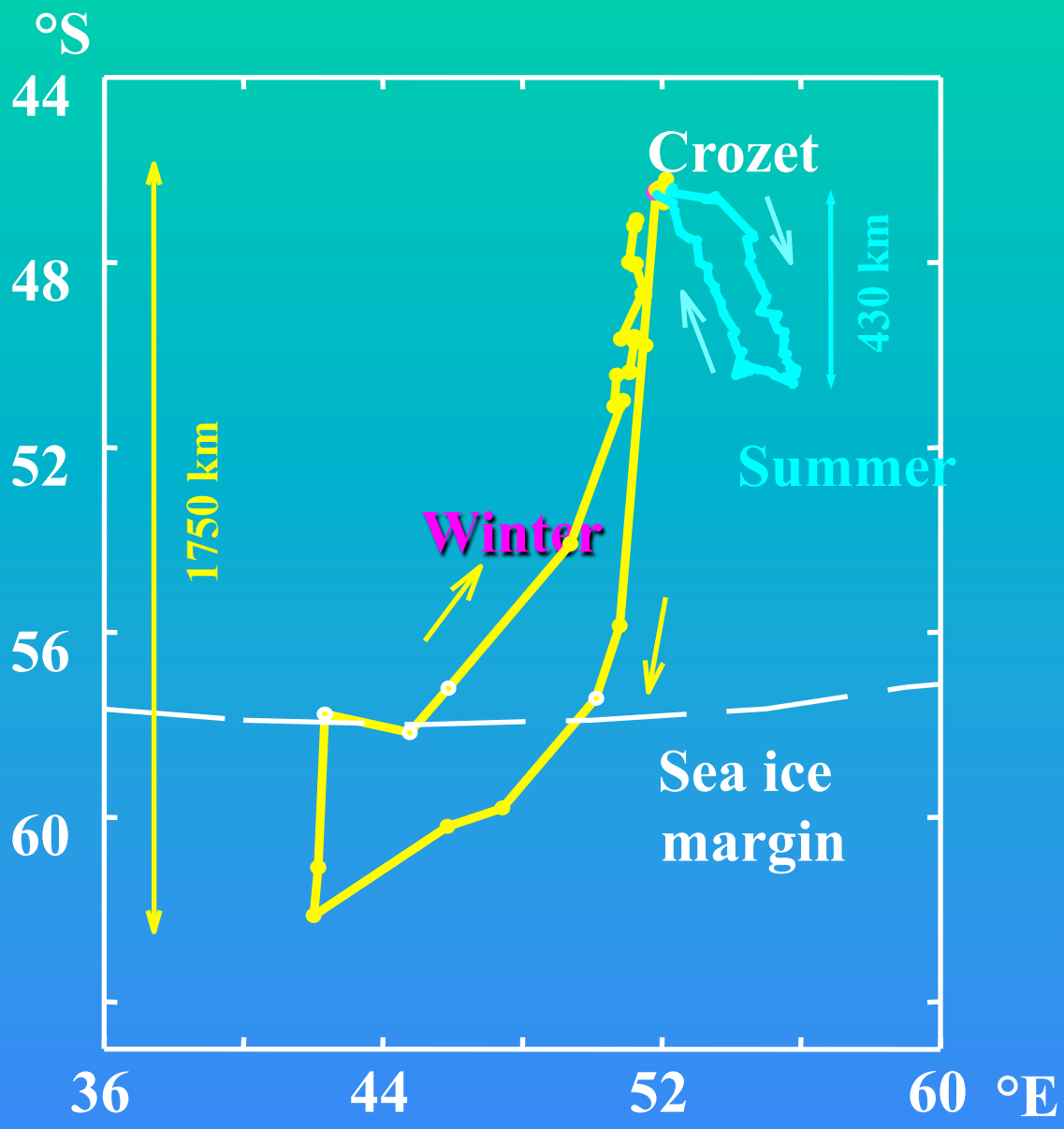


Ancel et al. *Nature* 1997
Pinshow et al. *Am. J. Physiol.* 1976

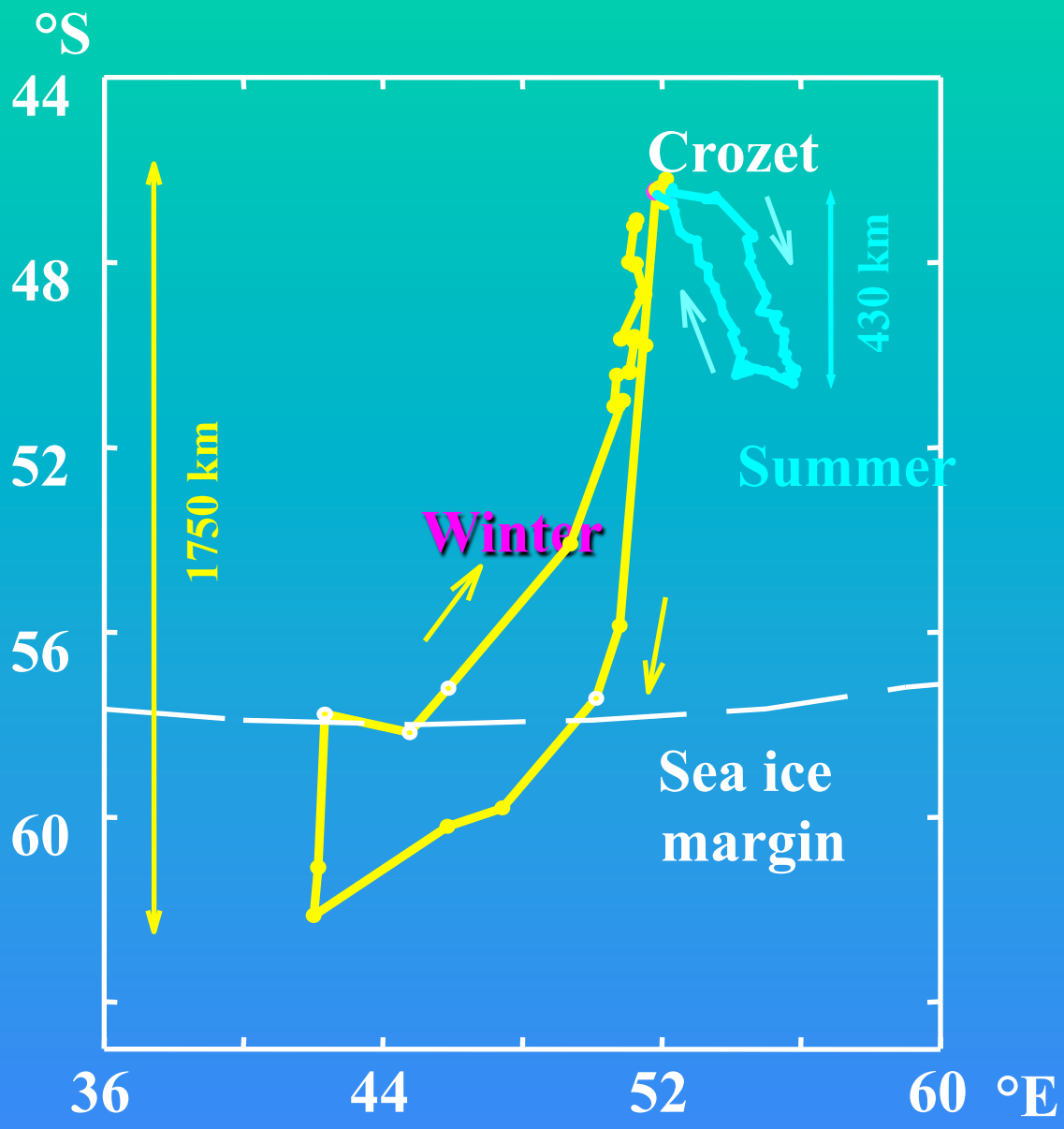


From Gilbert et al., *Am. J. Physiol.*, 2006

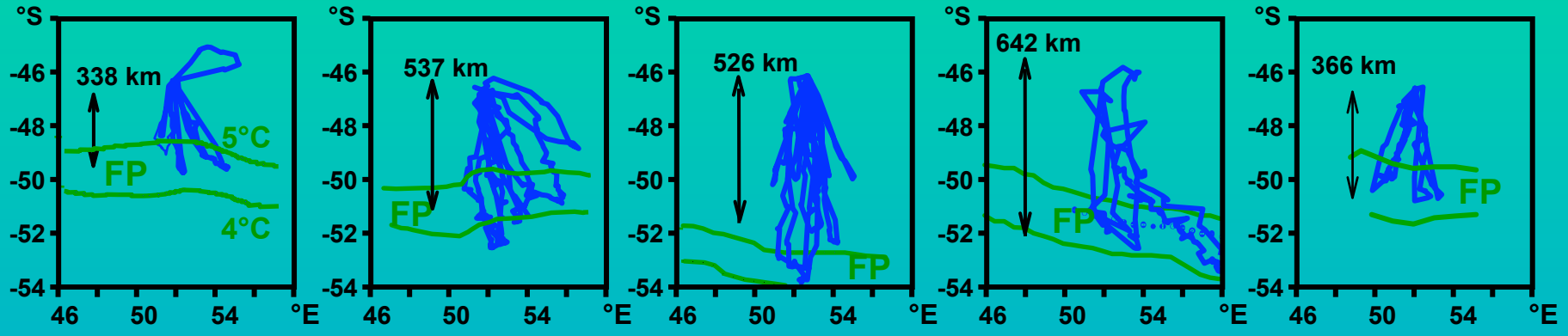

What about king penguins,
which live in a warmer environment?



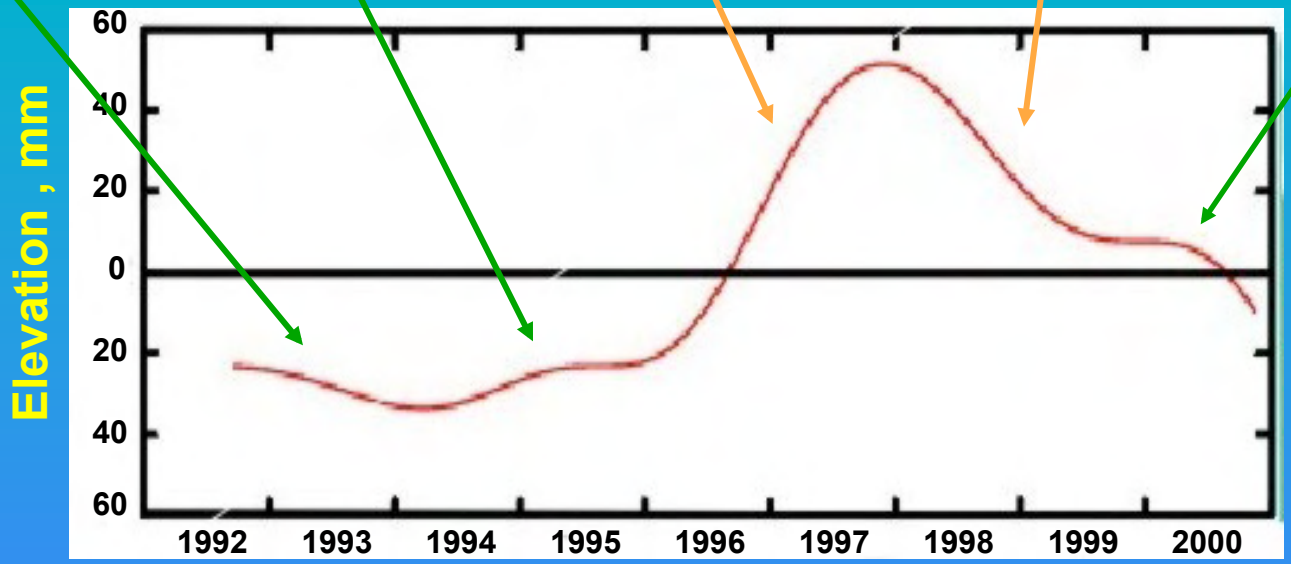
FromCharrassin & Bost, MEPS, 221: 285-297, 2001



FromCharrassin & Bost, MEPS, 221: 285-297, 2001



1994 1996 1997 1998 2000

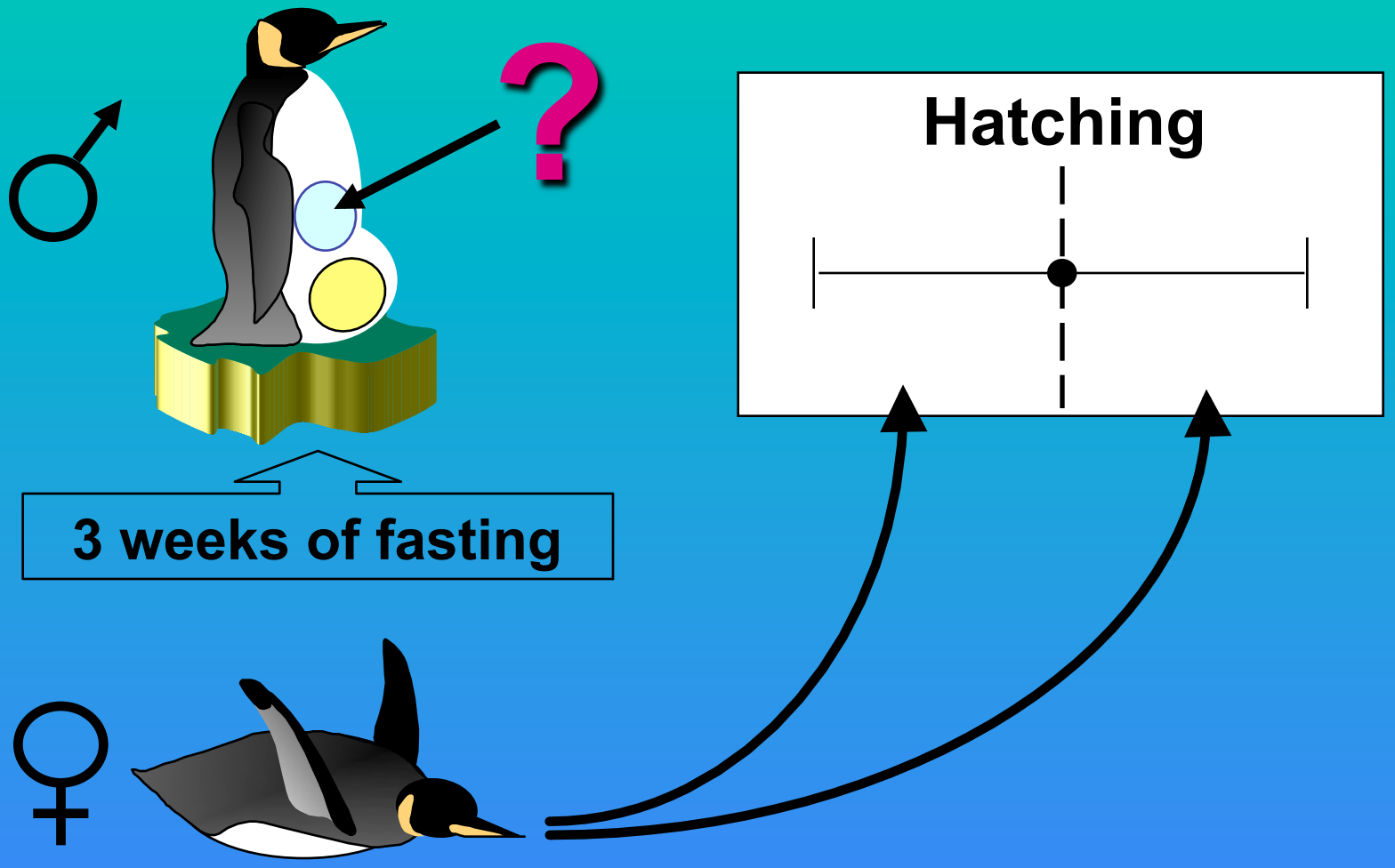


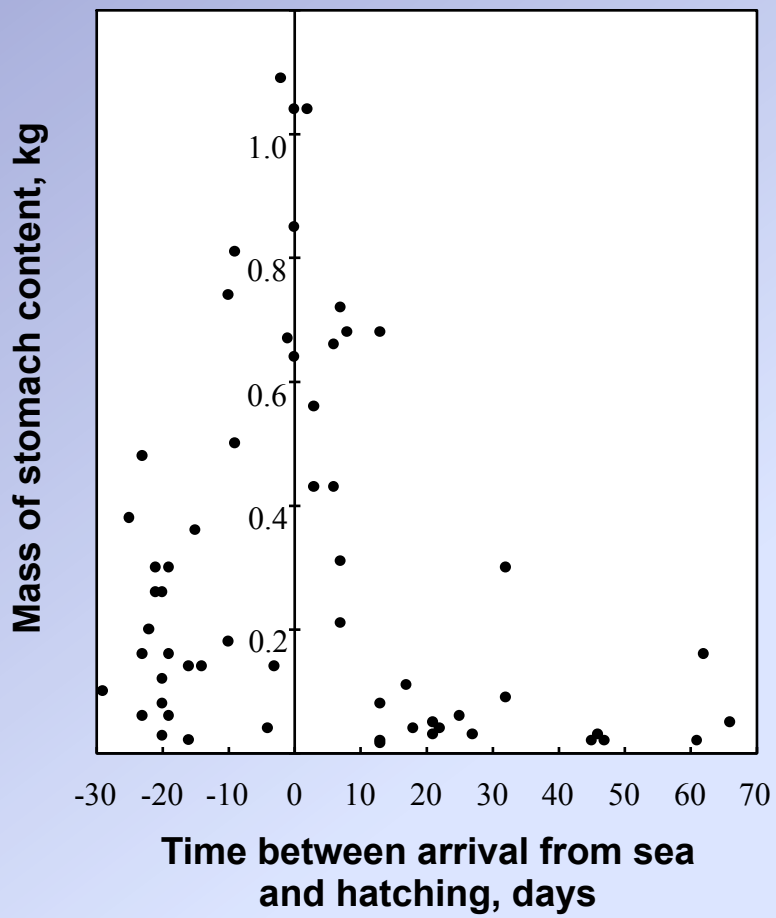
Sea level elevation at Kerguelen

King penguins are specialist feeders

Bost & al. In prep.

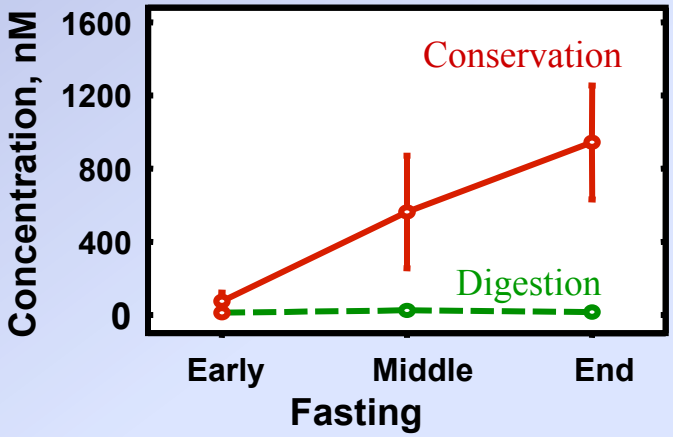
Variability in the duration of foraging trips





Gauthier-Clerc et al., Nature, 408: 928-929, 2000

Penguin peptide

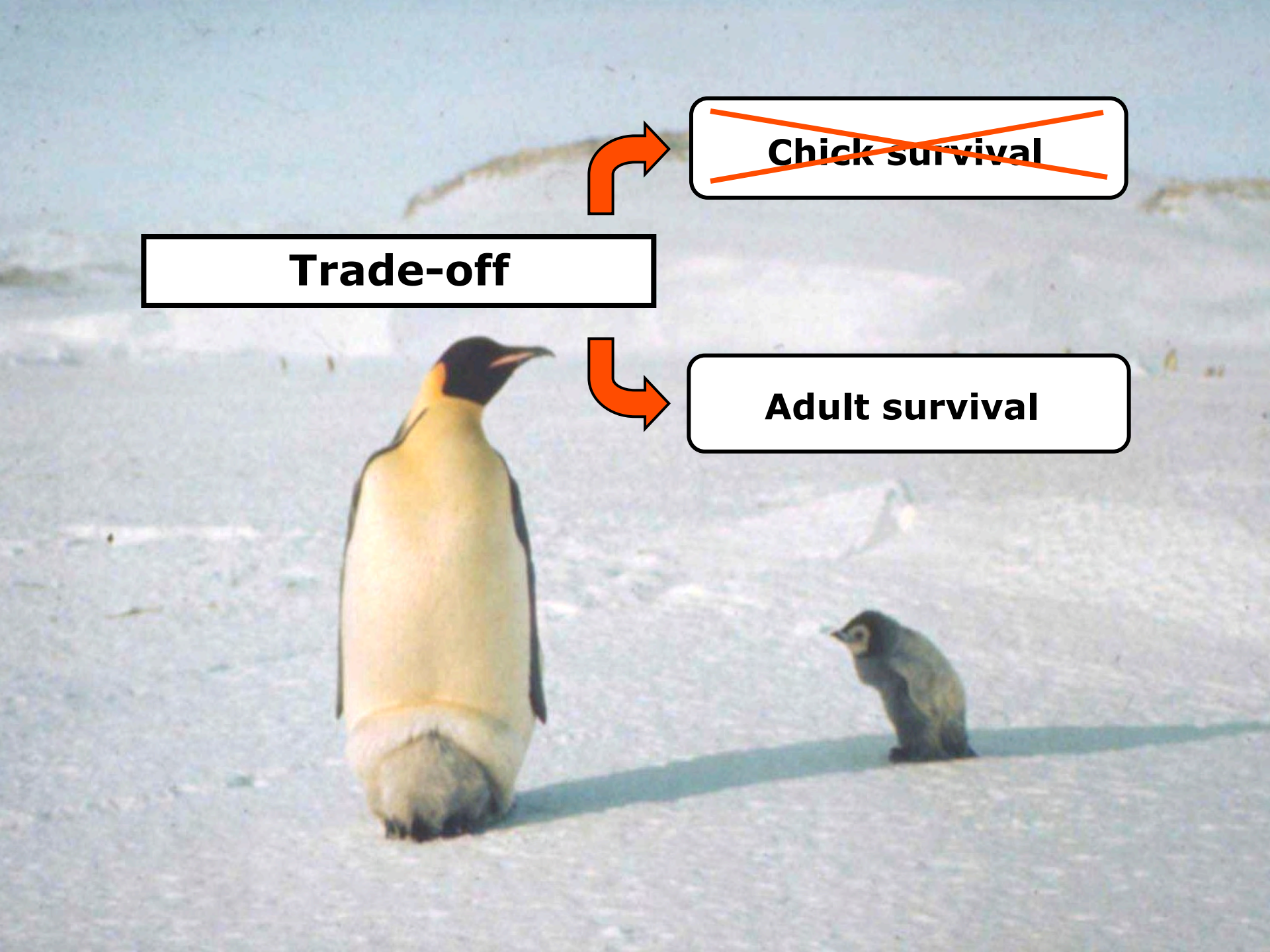


Effects on *Aspergillus fumigatus*

Control

+ Peptide (> 6 µM)

Thouzeau et al., JBC, 278: 51053-51058, 2003


Chick survival
Trade-off
Adult survival

Three phases during fasting:

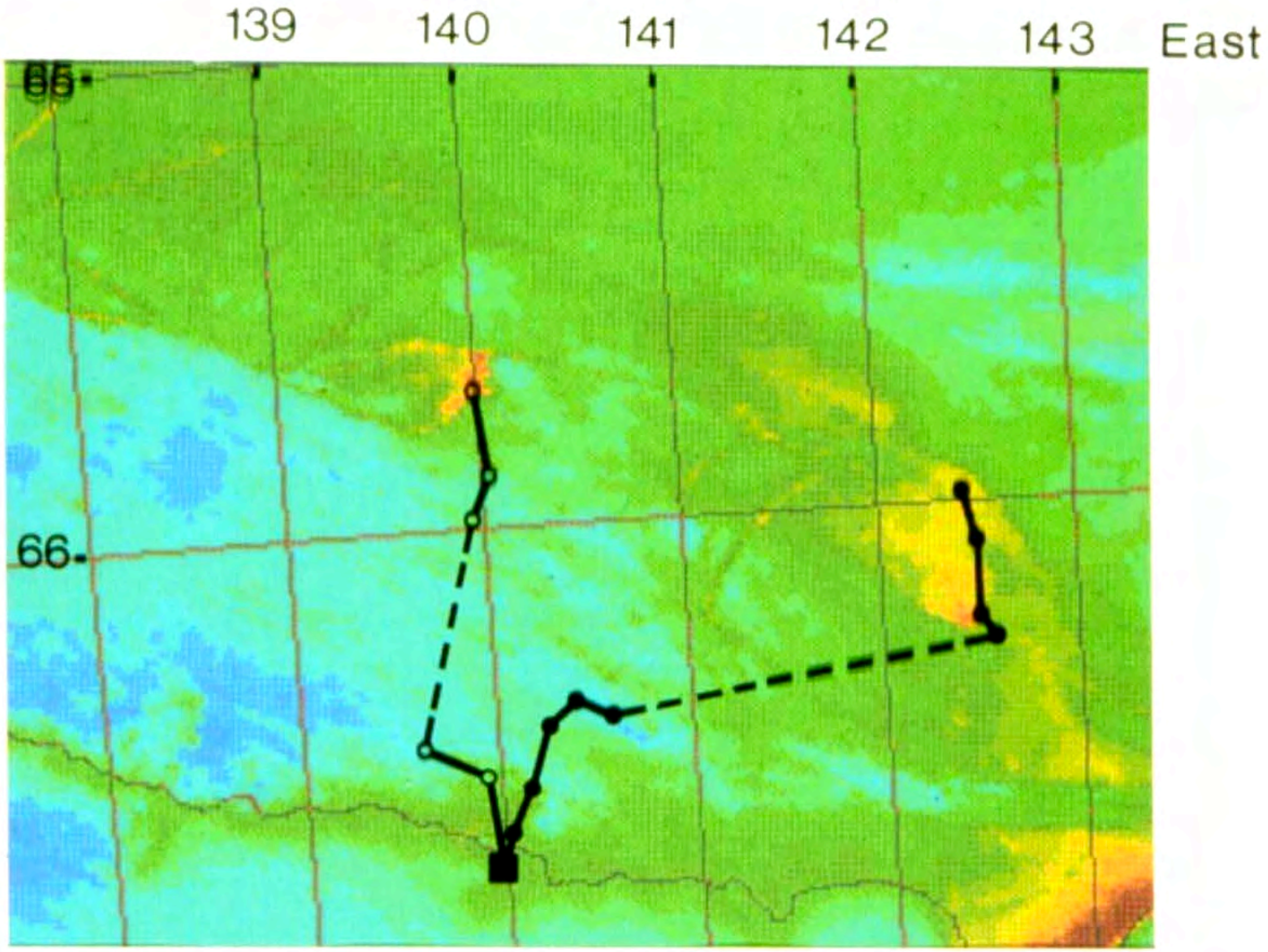
- **Phase I corresponds to the adaptation to a long fast.**

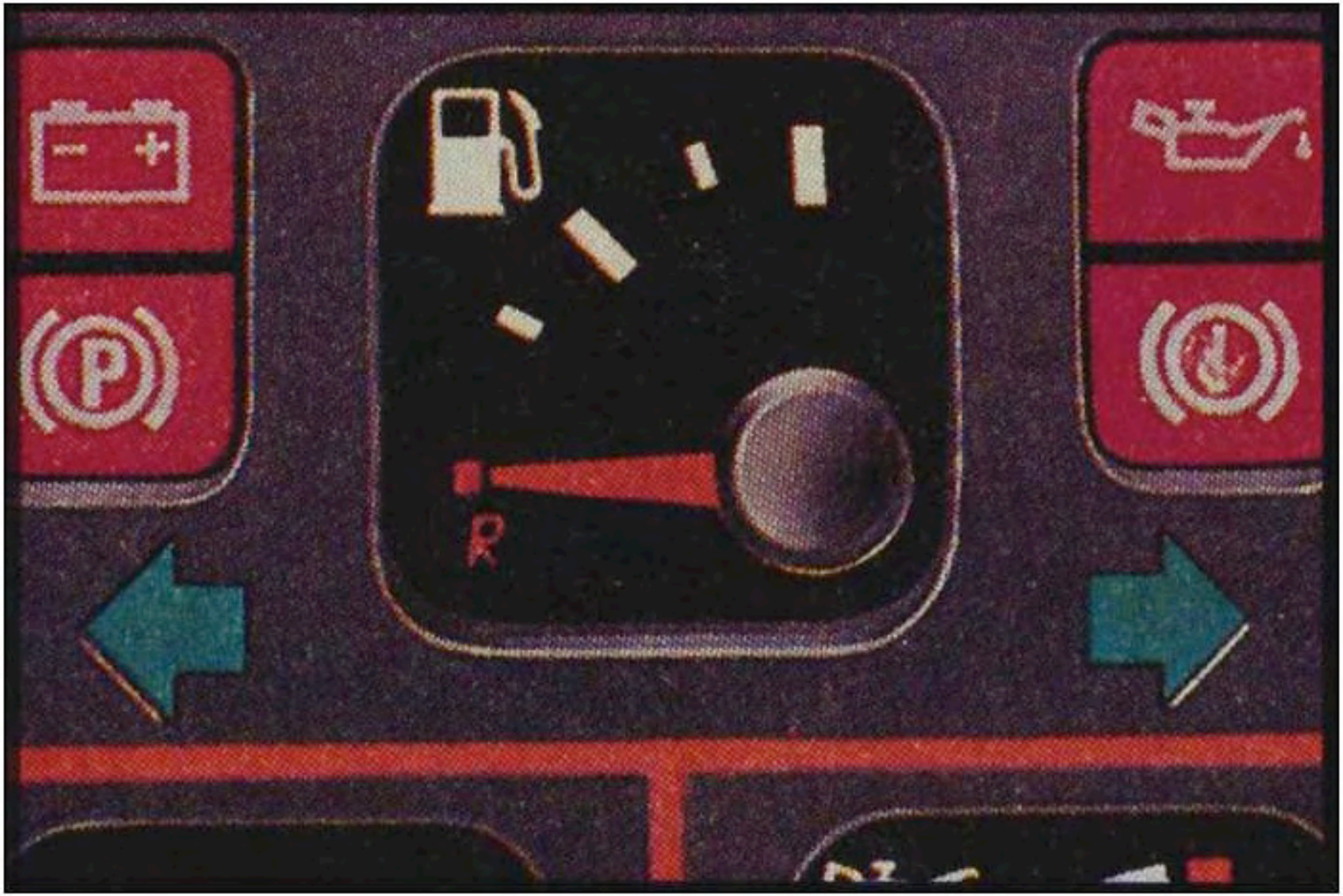
- **Phase II is a long period where body protein contributes to only 4% of the rate of energy expenditure.**

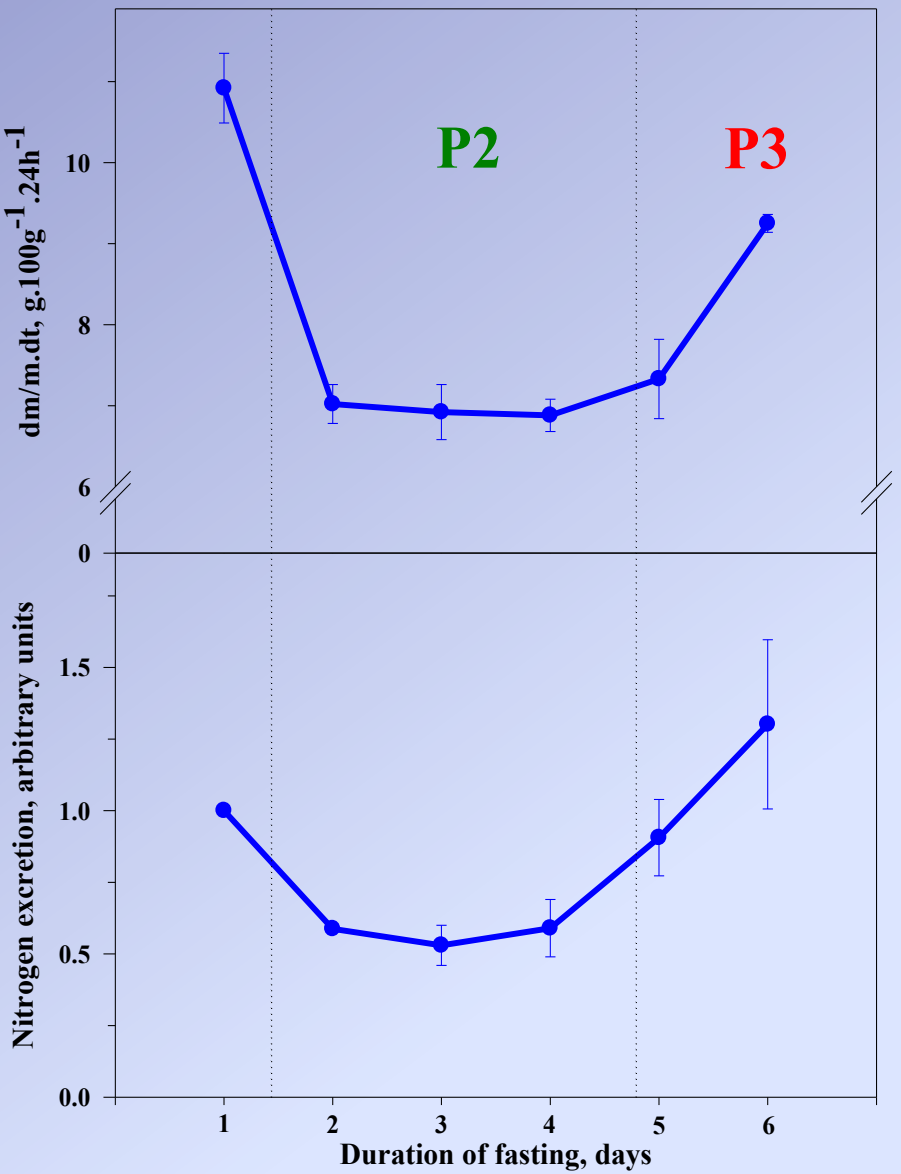
- **Phase III is characterized by a further rise in body protein breakdown, whereas significant lipid reserves are still available.**

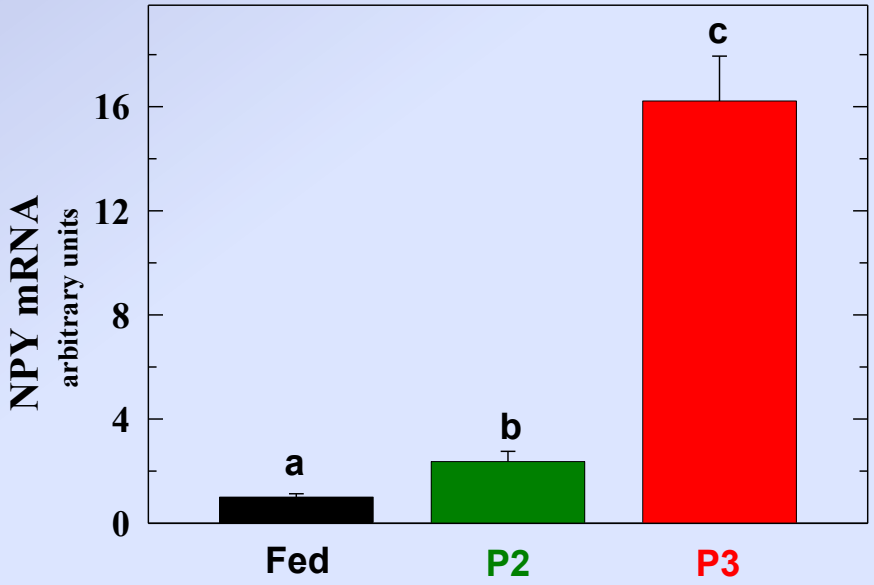
From Le Maho *et al.*, Am. J. Physiol. 1976

The birds abandon their egg or chick when reaching the stage of the shift from phase II to III.

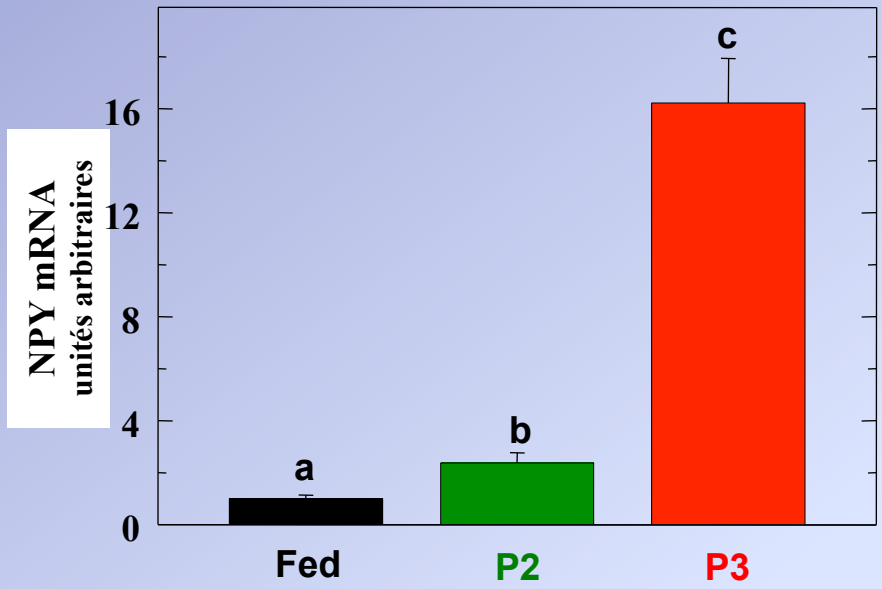

139
140
141
142
143
East
66
66
67
South


P
R

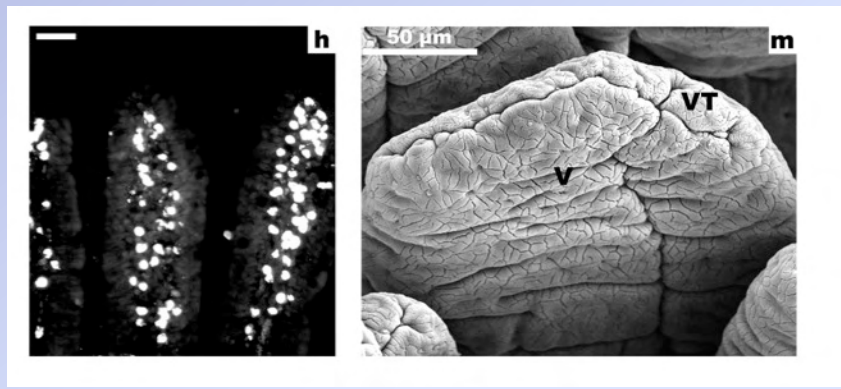




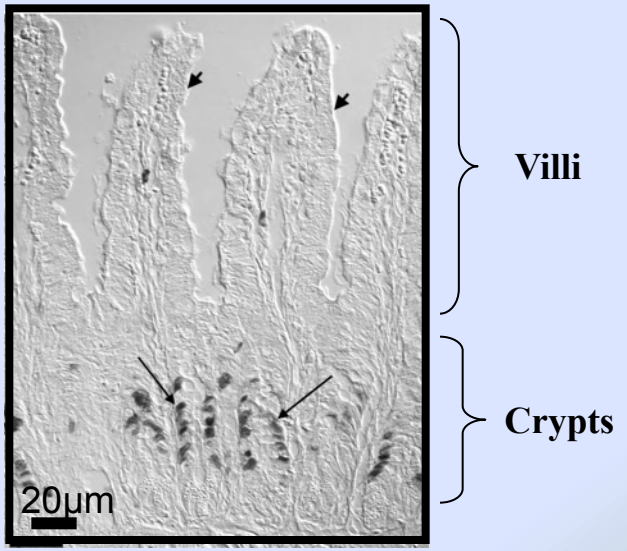
From Bertile *et al.*, BBRC, 2003



Production of neuropeptide Y



Suppression of apoptosis



Cellular division

Bertile *et al., Biochem. Biophys. Res. Com.* 2003

Habold et al., *Scand. J. Gastroenterol.* 2004 et *Eur. J. Physiol.* 2006

Are these behavioral
and physiological adaptations sufficient?

Will antarctic penguins

survive to climate change

according to IPCC scenarios?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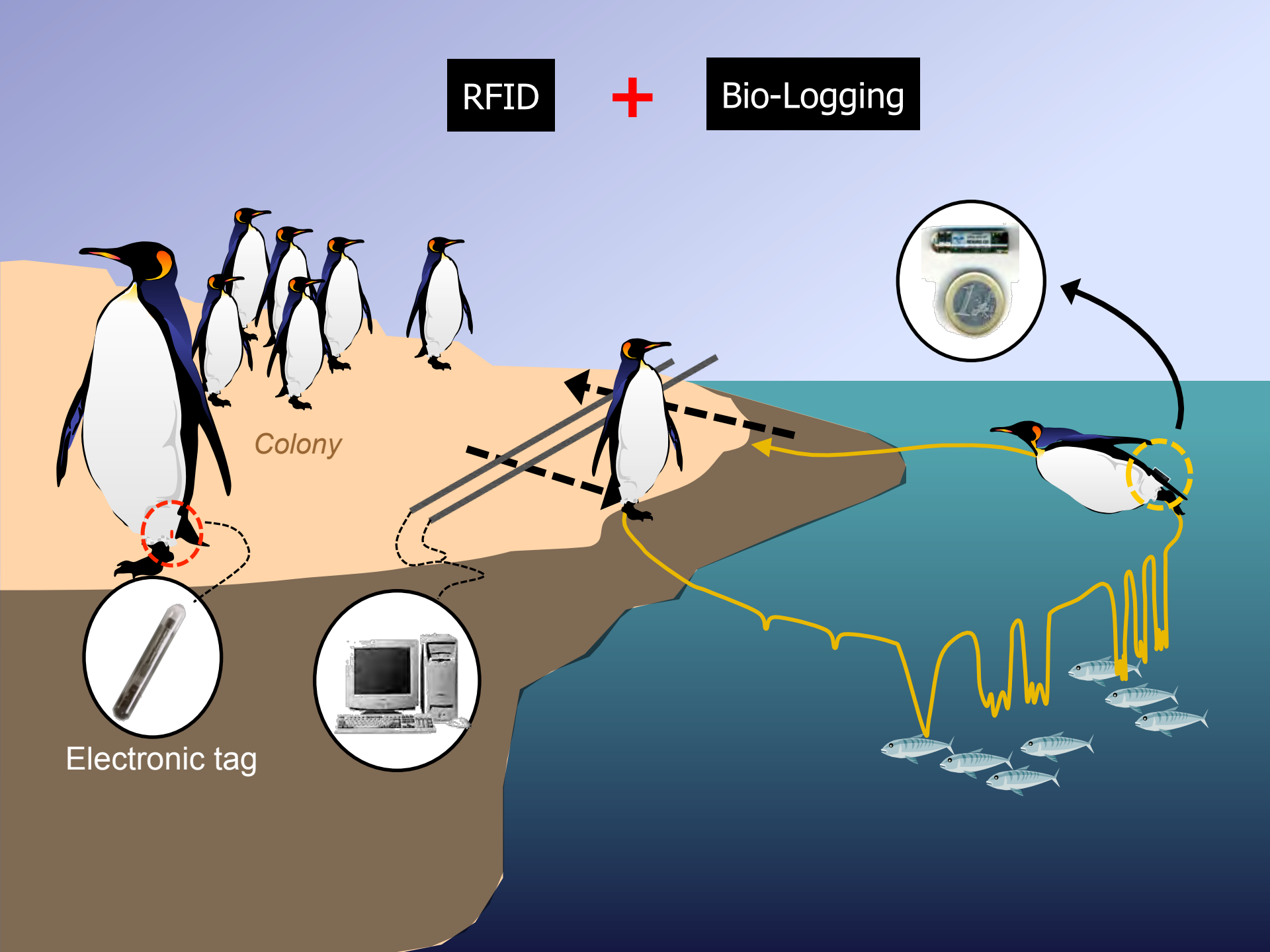

RFID
+
Bio-Logging
Colony
Electronic tag

Flipper bands induce:

-Longer foraging trips

-A delay in breeding

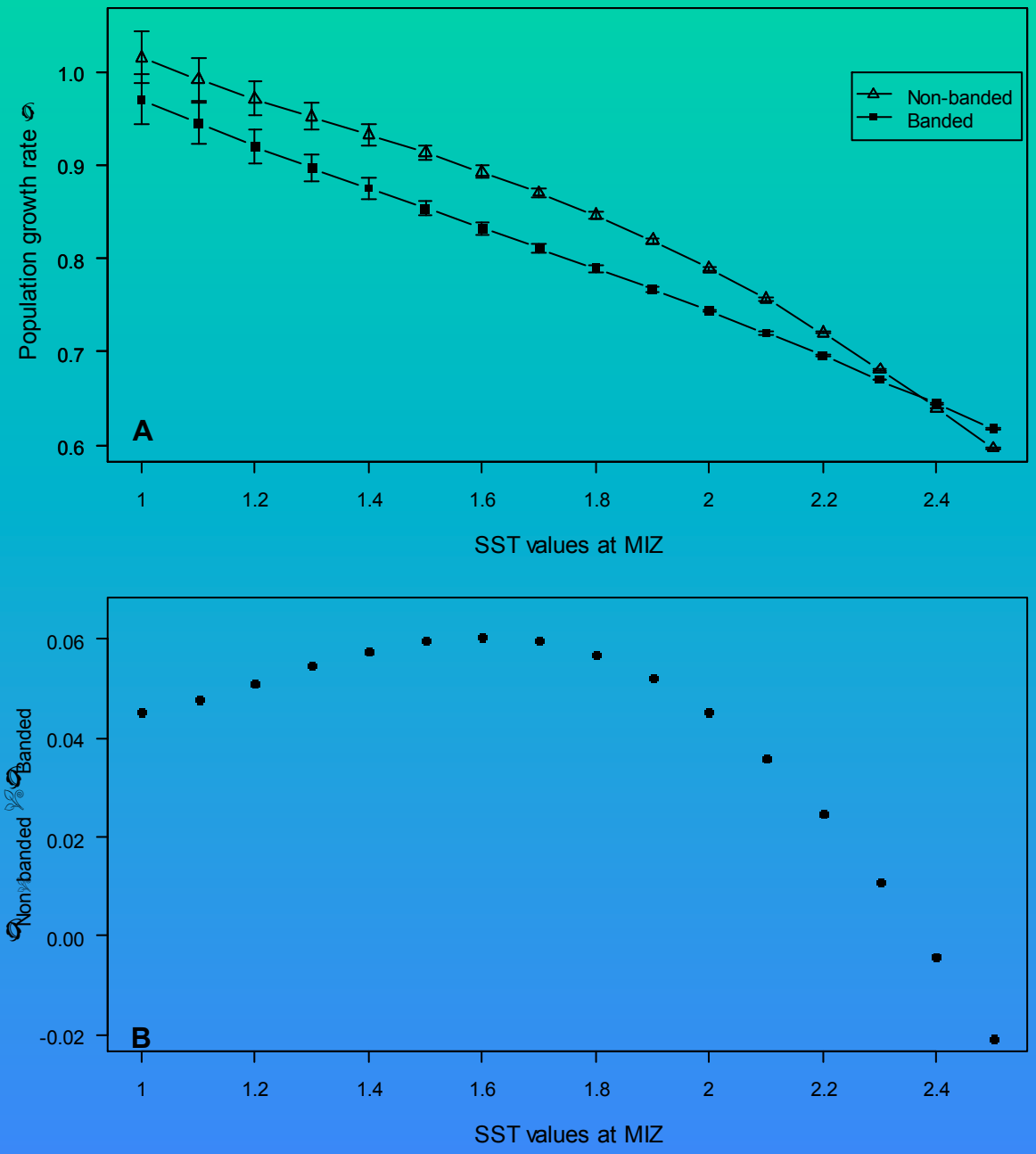
-A lower proportion in breeding

-A drop of 40% in breeding success

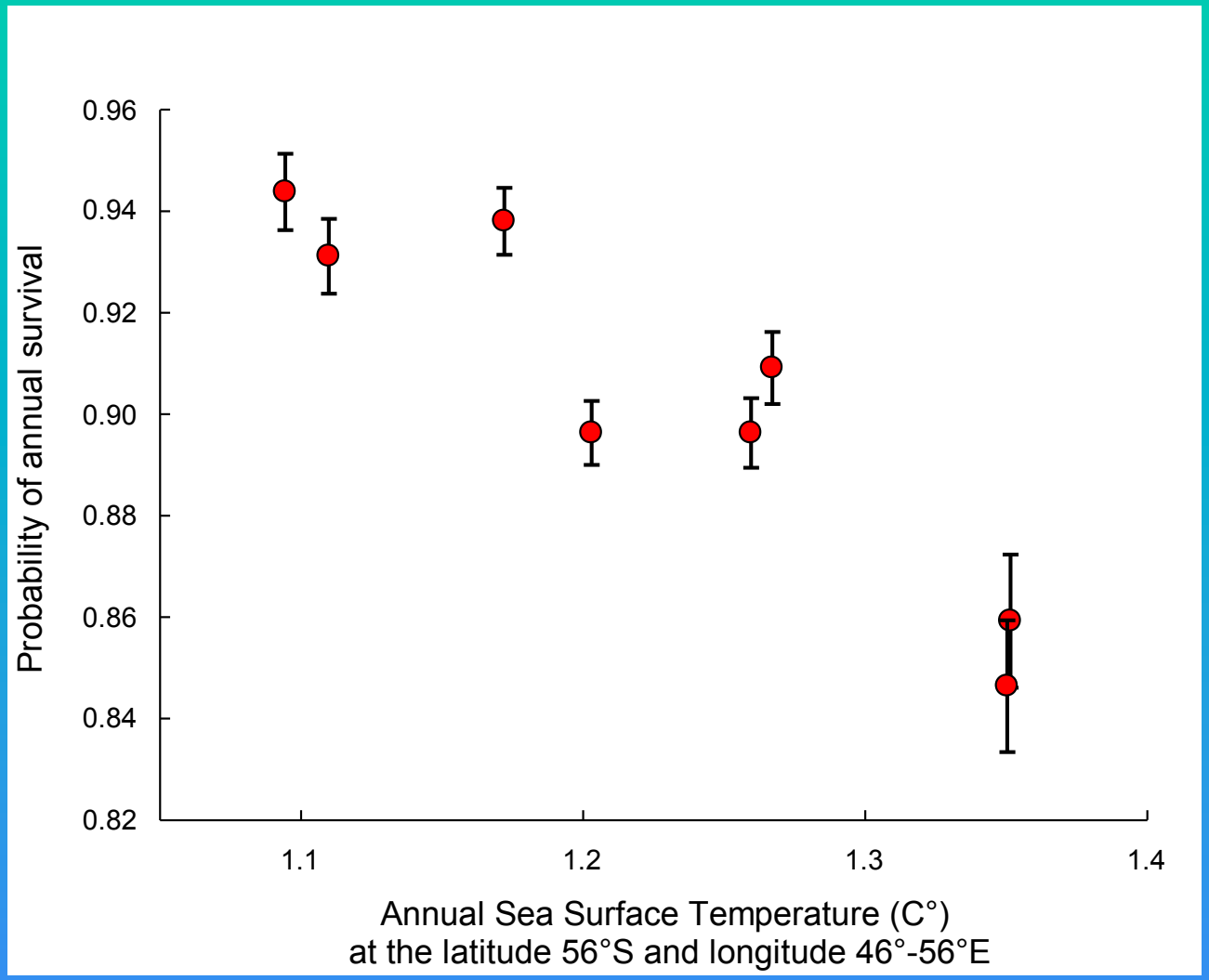
-A drop of 44% adult survival over 10 yr

-A drop of 50% chick survival over 3yr

Saraux et al. (2011). *Nature* 469: 203-206.



Saraux et al. (2011). *Nature* 469: 203-206.



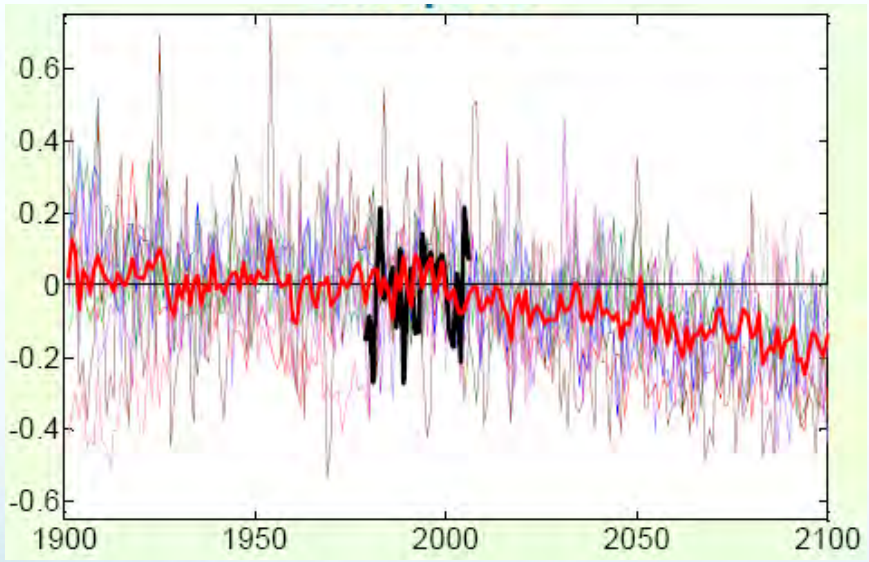
IPCC prediction:

an increase of 0.4°C in the next 20 years…

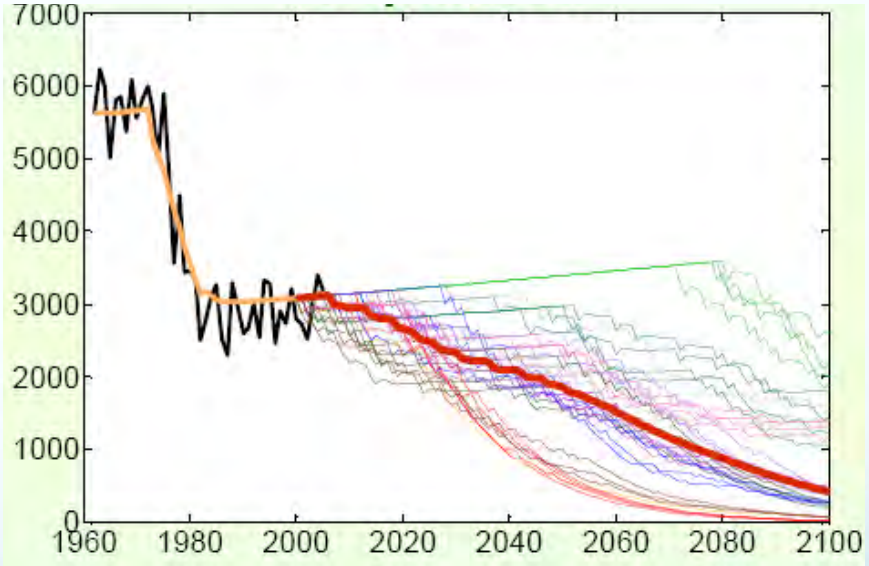
Le Bohec *et al.* PNAS, 105: 2493-2497 (2008).

Scenarios for the future

Models of population dynamics



Prediction of sea ice (IPCC models)



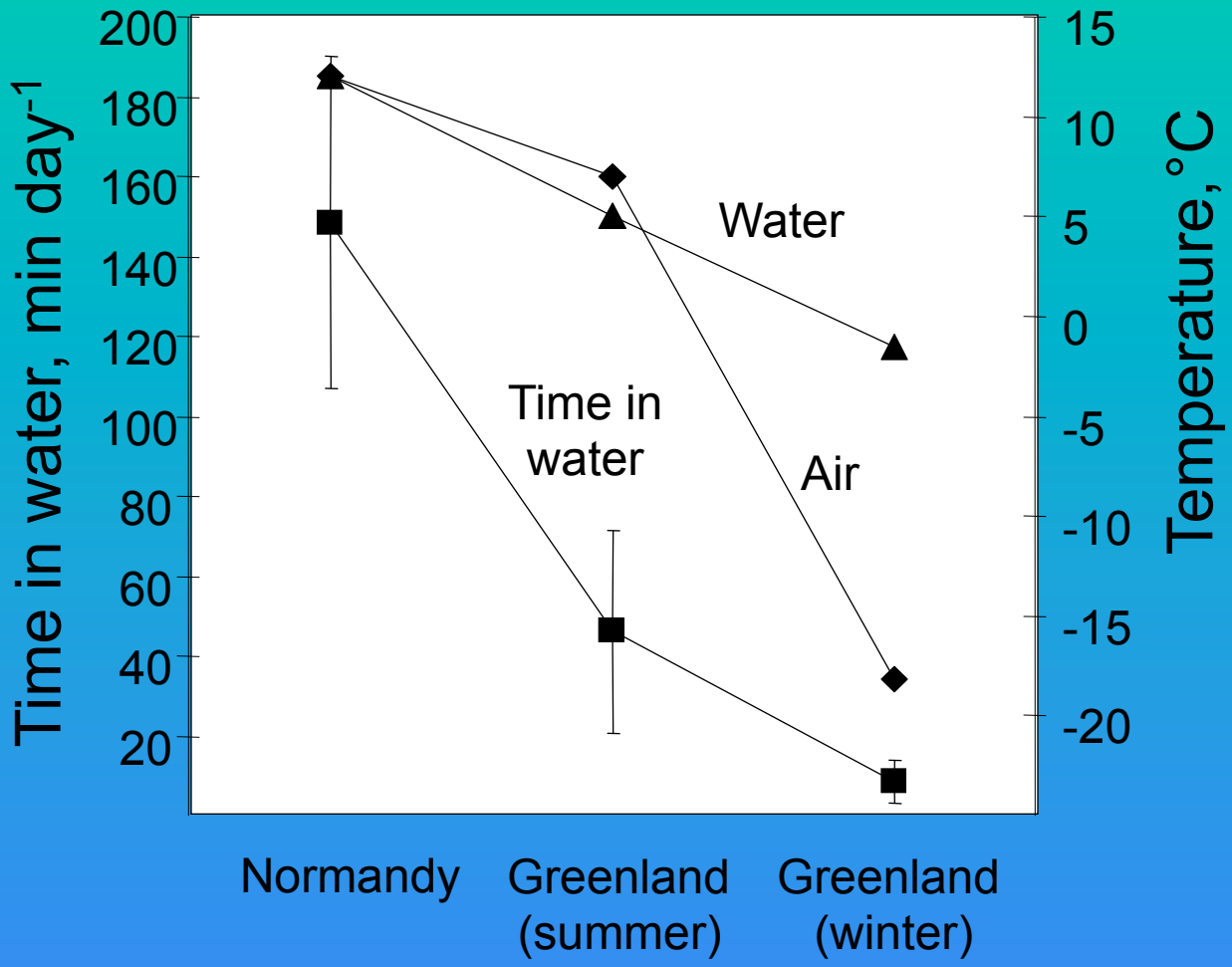
Prediction of number of couples

Jenouvrier et al. *PNAS 106: 1844–1847 (2009).*

Centre d'études biologiques de Chizé

A bad time for long-lived specialized birds!

But what about generalists, i.e. more flexible birds?



Grémillet et al. *Ecol. Lett.* 4: 180-184, 2001

Main messages to take home:

- Severe cold is not a problem for penguins.

-Their main problem is the effect of climate on the abundance and localization of the prey on which they rely as specialist feeders.

-A slight warming of sea temperature is sufficient to jeopardize their future.

-There is a better future for generalists.

SUPPORT :

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Université Louis Pasteur, Strasbourg
Fondation Total
Fondation Bettencourt-Schueller

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